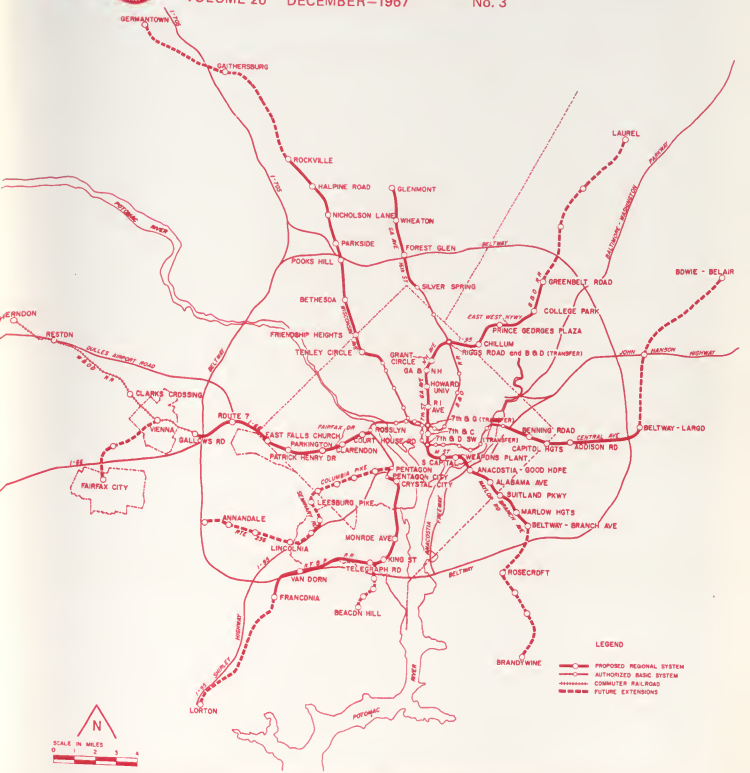
Mechelectiv

VOLUME 26 DECEMBER—1967 No. 3



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DECEMBER 1967

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MECHELECIV

WHAT'S IN THE FUTURE?

197? Where did you get your Bachelors Degree? George Washington University in Washington, D. C.? Do they have an Engineering School? Oh, I see. When did it close?

Is this dialogue unrealistic? For those of us close to the School of Engineering and Applied Science it is too realistic for comfort. It is also a matter for grave concern. The faculty, administration, and alumni are very concerned that this dialogue will become reality, and, in addition, every student registered in Engineering should and MUST take an active part in preventing the demise of an engineering program at The George Washington University.

There is little chance such a situation will occur while any of us are still undergraduates, but one has only to examine the trend in our freshman enrollment to see that we are not far away from being a Graduate School of Engineering. Granted, it is easy to sit behind a typewriter and say we need larger freshman classes. This is not my intent. What I want to point out is a question that concerns us all – How can we interest a high school senior in coming to our school when the majority of US aren't interested in the school? We must create for each student an interest in the school, its activities, and its well-being so that we may then take an active part in its destiny.

How many of you Freshmen are involved in any of the professional societies – or you Sophomores – or you Juniors? The Seniors are involved because they have come across a space on job applications entitled "Activities". After letting it go blank once, they realize that prospective employers are interested in well-rounded applicants, and so they join something. Once involved, they realize what they have missed and what they could have accomplished had they joined as Freshmen or Sophomores. I urge all of the undergraduates to take an active part in some extra-curricular activity in the Engineering School. By so doing, you will generate, within yourself, a genuine concern for the school that you can convey to those coming behind you.

This continuity of interest, or school spirit, is what we need to start our school toward greatness. If each of us is interested, we will have no trouble convincing high school students they should study Engineering at George Washington. We can be instrumental in keeping the school aimed in the right direction. If each of us *puts* a little into the School of Engineering and Applied Science, instead of just *taking* courses and *taking* a degree, perhaps the dialogue will be somewhat different.

Where did you get your Bachelors Degree? George Washington? That is a great Engineering School

the Mechelecivan

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ARTICLES

DEPARTMENTS

COVER

WMATA proposed regional system for Rapid Rail Transit, October 20, 1967.

FRONTISPIECE

Photograph of the Earth taken from an altitude of 22,300 miles by ATS-III.

Published at the George Washington University by direction of the Engineers' Council. Published six times during the school year in October, November, December, March, April, and May. Second class postage paid at Washington, D. C. Address communications to Mecheleciv Magazine, Davis-Hodgkins House, George Washington University, Washington, D. C. 20006, or telephone 676-6726.

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CAMPUS NEWS

THETA TAU EASTERN REGIONAL CONFERENCE

Theta Tau, national professional engineering fraternity, held its biennial Eastern Regional Conference in Syracuse, New York with the Chapter at Syracuse University as the host chapter during the Thanksgiving Holiday. Theta Tau is presently divided into five regions, namely, Eastern, Northern, Central, Western, and Southern which each hold conferences during the fall of each odd numbered year. The Eastern Region is composed of Tau Chapter at Syracuse University, Theta Chapter at Columbia University, Gamma Beta Chapter here at George Washington University, Pi Chapter at University of Virginia, and Rho Chapter at North Carolina State University.

With delegates from each chapter in the region in attendance, the conference covered such topics as rushing, pledging, obtaining and maintaining a chapter house or headquarters, and participating in school and community activities as well as discussions on the various aspects of fraternity principles and operation, workshops, and most important an opportunity for fellowship with Theta Tau student and alumnus members from throughout this region. With each delegation giving a talk on one of the above-mentioned topics regarding their activities concerning their talk, the major portion of the conference was based on discussing the various aspects of each lecture and to solicit suggestions and comments for the improvement of the fraternity and the chapter in that particular area.

Leading the discussions were our Regional Director and our Grand Regent, Brothers John M. Dealy and C. Ramond Hanes, respectively. These gentlemen with their wisdom and knowledge of fraternity customs gave lectures on the duties of the various officers and on the procedure involved in running and maintaining a chapter. During this time, advice was given and taken as to the various aspects of chapter operation and how each chapter could improve in these respects.

The highlight of the conference occurred not as a scheduled event, but one which was none-the-less the most hilarious and dangerous happening of the conference. This occurred during the first night of the conference when almost all of the brothers were asleep in the chapter house. Around one in the morning, an attempted burglary was foiled by three of the brothers and the burglars were apprehended after a chase by the Security Force of Syracuse University and the City Police. For our efforts, the brothers spent the remainder of the night in the police station making statements even though most of the brothers slept through the disturbance, author included. With this under our belts, the conference started in earnest the same morning and all were in a wide awake state of mind. Even with this, much was accomplished and this I must say was due to the advance planning of the host chapter.

Because of what was learned at this conference we the brothers of Gamma Beta Chapter hope to improve and change the trend of The School of Engineering and Applied Science here at George Washington University from one of downward enrollment to one of increasing enrollment and to further help the school in any way possible.

SPRING REGISTRATION

Spring registration will be on an alphabetical basis. Students whose last names begin with A through K register on Thursday, January 25th. Those with last names beginning with L through Z should register on Friday, January 26th. Registration on Saturday, January 27th will be open to all students without reference to alphabetical breakdown. There will be no preregistration for the Spring semester.

SIGMA TAU

Sigma Tau has extended membership to Professor Barry Hyman of the Engineering Mechanics Department of The George Washington University.

The following students also became members of Sigma Tau:

James Harris	Stephan Klare
Jorge Hidalgo	Phil Kraus
Donald Howard	Joseph Obyrne
Lawrence Kastner	Thomas Packard
Robert Keltie	Curtis Schroeder

Initiation ceremonies for the new members were held on Sunday, December 10th. A banquet was held with the members of Tau Beta Pi at Evans Farm Inn, McLean, Virginia.

TAU BETA PI

Initiation ceremonies were held by Tau Beta Pi on Sunday, December 10th for the following students:

William Herman
Robert Keltie
Michael Rohrer

A banquet for the new members was held with members of Sigma Tau at Evans Farm Inn, McLean, Virginia. Dr. Patrick Gallagher, Anthropology Department, was the guest speaker.

Doesn't it seem like yesterday when you took everything in the house apart. First the toy cars and trucks . . . then your electric train . . . finally mom's toaster. You caught it for that, but you found out how everything worked, and later why.

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THE CONSULTING ENGINEER

by Bud Wareham

When asked to prepare this article, I cast about for some ideas and decided to go through some back issues of the *Mechelecіv* Magazine. Instead of easing my task, it made it more difficult and I felt like the horseman who rode in all directions. I was impressed by the number of serious questions being asked with regard to the Engineering School, engineering education, professionalism, the large number of ads all hoping to attract students to their companies for a career, and articles about some rather deep subjects such as radio, radar, laser beams and UFO's. What should be the subject of my article? Should it be a review of the achievements of our alumni organization, its aims and needs in the future? Should it be some comments about the professional engineer, or some gems of wisdom taken from experience in the work-a-day world, or some comments about engineering education — all seemed needed and appropriate. Perhaps a number of these can be combined in the article which I am about to begin.

For, while there are a large number of articles enticing you to work for this steel company or that aircraft company or this electrical manufacturing company, most skirt what you as student engineers are probably most interested in. What are the real requirements, background and personality that you should have to be a success with that company? What are the rewards, both financial and personal? What will I actually do if I work for that company? These are questions which while I cannot answer for the steel company or that aircraft company or this electrical manufacturing company, I can speak personally about a career which I have found to be most satisfactory. A career as a Consulting Engineer in the construction field. And perhaps, if there is sufficient interest, this could be simply the first of a series of articles prepared by a number of our GW alumni giving you the straight from the shoulder facts about their careers and their particular industry. Over a period of time you would have available to you some fairly basic information which could serve as a guide in making your choice of a career.

WHO IS A CONSULTING ENGINEER?

A Consulting Engineer is usually a self-employed graduate, registered professional engineer. An Engineer who, after graduation and a number of years working in the profession obtaining qualifying experience under the guidance and direction of a registered engineer, has passed sixteen hours of written examination and become licensed in his own discipline (i.e., electrical, mechanical, civil).

While self-employed he may be a sole proprietor with only a secretary for additional staff; may be a member of a one, two, three, four or five-man partnership with two to several hundred engineers, draftsmen, secretaries and other help working for him. He, and or his firm will supply engineering services to government, industry, commercial and individual clients ranging from brief consultations to solve an immediate problem, to the complete planning, design and field inspection of a major project. While in a number of instances he may be working directly for an individual owner, quite often he serves an owner indirectly by working with an architect who is employed by an owner.

A Consulting Engineer usually specializes as electrical, mechanical, electrical-mechanical, civil or structural consulting engineer. These constitute the majority, but there are other specialties such as accoustics, antennas, radio, electronic and others in the consulting field.

THE CONSULTING ENGINEER IN CONSTRUCTION

A consultant in the construction field provides the working drawings and specifications for the mechanical, electrical, plumbing or structural portions of construction projects ranging from shopping centers, apartment houses, office buildings, to bridges, highways, etc.; also providing feasibility reports and general review of the construction. Let's take a closer look at the Consulting Engineer in the construction field and examine just how he operates.

In preparing plans and specifications, the engineer takes standard manufactured items and assembles them to form a coordinated operating system designed and applied to suit the requirements laid down for the particular project he is working on. That is, the Consulting Electrical Engineer would lay out lighting fixtures of many types, conduit (electrical raceways), wire, panels, switchboards, motors, starters, motor control centers, fire alarm stations, gongs, control panels, annunciators and all of the other electrical apparatus which goes into a modern building; show on drawings where these are to be located — sizes, dimensions, types, manufacturer, catalog number, etc. for each particular device, with all the wiring and proper connections shown so that they may be first estimated and later installed in the proper place to form a complete working electrical system. The Mechanical Consulting Engineer will lay out air handling units, exhaust fans, pumps, refrigeration compressors, cooling towers, pipes, tanks, motors, and a myriad of other mechanical items to form a complete mechanical system for

IN THE CONSTRUCTION FIELD

E. A. Wareham is the President of the GWU Engineer Alumni Association. He received a BS degree in EE from GW in 1953. He is a partner in the consulting firm of Frank J. Sullivan Associates. In addition, he serves as chairman of the Education Committee of the Consulting Engineering Council of Metropolitan Washington.

the same project. The Structural Consulting Engineer will design the steel beams, columns, and structural steel concrete, detailing same for the structural system. All of these drawings combined with the architectural drawings prepared by the architect to form a complete package, permit a general contractor to build the project.

The Consulting Engineer usually employs a number of draftsmen, some of whom may be engineers who eventually may pass registration exams and become consulting engineers themselves. A young engineer working in a consultant's office will be called upon to do drafting, since a great portion of the consultant's work is shown on drawings a great portion of the time spent by the consultant's office is spent on drafting. Many clear and concise details are prepared and many drawings are made before a project is completely designed and specified. A great deal of the design that is performed by the consultant is based on his past experiences. The successes or failures, the mistakes he has made all are considered in making his design.

THE REGISTERED PROFESSIONAL ENGINEER

Years of experience are necessary before one is ready to be registered, as it takes years of practice and many mistakes before being qualified. Discouragingly enough very little that is taught in college today or in my time is particularly or immediately useful to a consulting engineer in the construction field. However, the problem solving ability learned in school applies in any business and applies very much in consulting engineering. Success or failure as a consultant is primarily based upon the years of experience achieved working under the guidance of qualified engineers, a chance to put together systems under experienced guidance by those who have previously made their mistakes.

The opportunities are great for the Consulting Engineer in the construction field since the consultant is involved in most of the building projects you see going up around you. The construction industry is the nation's largest industry and the consultant is one member of this industry. There will always be construction and there will always be the consultant working as one member of a large team in the construction industry.

The personal rewards are there also. The personal pride in seeing a building you have had a hand in designing being built before your eyes, supervising the construction and making the final inspections. You receive a great satisfaction in being part of this creativity.

Financially the rewards are here also. While starting salaries are not as great as some of the aerospace and research type industries, the starting salaries are comparable with most other industries. With registration, particularly, a more than adequate living can be made as a consultant with income ranging on the order of $20,000 to $35,000 per annum.

What kind of person does it take to be a Consulting Engineer? I believe it takes a person who is practical (which I think most engineers are), resourceful, awake, rather normally balanced, somewhat of an extrovert, willing to accept comprise (since a large amount of design in the construction business is based on compromise), a drive to improve and imagination. These traits make a successful consultant.

The consulting field is not a field where a tremendous number of graduates are needed, but it is a field where a steady flow of graduates can be absorbed, finding their place in the profession. It is, most of all, the professional practice of engineering. The engineer is legally responsible for his designs, can be and has been sued when he fails. He is licensed by the state board of registrations of each state and only when he has the necessary qualified experience and has been examined carefully by the professional registration board is he permitted to practice consulting engineering. The consulting field could and should be the highest aim of the graduate engineer, and before long I feel will take its place with the other great professions, notably, the medical and law professions, as its contribution to society is equally great. The medical profession providing us with health, the law profession with justice, and the engineering profession providing us with the wherewithal to live; our home, our place of work, our schools and churches.

The Consulting Engineering Council of Metropolitan Washington, an organization made up of a number of the consulting firms in metropolitan Washington provide an opportunity each summer for a limited number of college engineering students to taste a little bit of life in private practice by employing them on a summertime basis. Better than over sixty students were employed last summer in the metropolitan area. If this article intrigues you to investigate further, I would be happy to discuss it at any time and have you visit our office or some other office that might interest you in the discipline of your choice and to see if we could line up some summer employment for you.

RAIL RAPID TRANSIT FOR THE

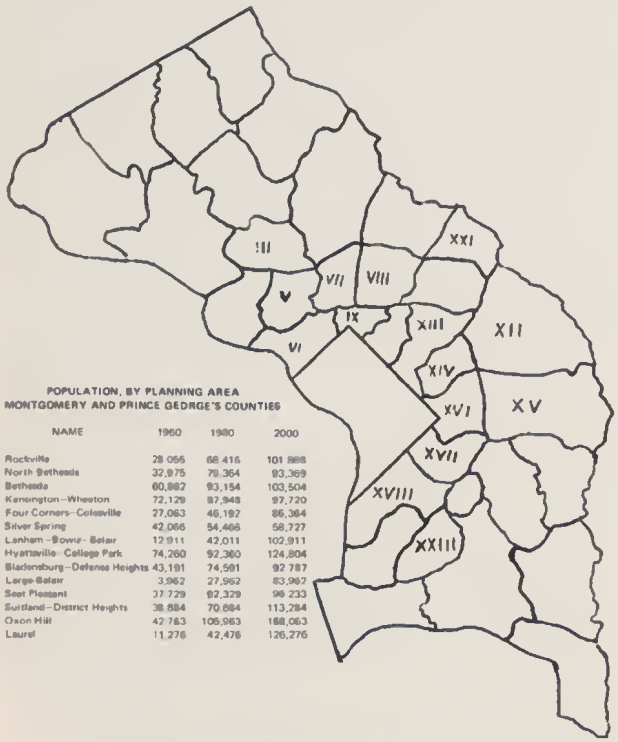
by Ely G. Fishlowitz

INTRODUCTION

Washington, D. C. will soon have a rail rapid transit system. Trains are scheduled to be in operation in the early 1970's. This article discusses the mass transportation problem facing the Washington area and describes how rail rapid transit is a major part of the solution to the problem.

MASS TRANSIT PROBLEM

Much attention has been focused in recent years on the transportation problem in the Washington, D. C. metropolitan area. Basically the problem is one of how to adequately provide for the ever increasing mass of people who twice daily have to travel in and out of the city to and from their jobs. This mass-of people, known as commuters, battle the clogged arteries filled to overcapacity with automobiles, buses, and trucks, and arrive downtown where they find they must search for the scarcest of all commodities, the legal parking space. Some in desperation have turned to buses, whereupon they wait in long lines to board a crowded bus and ride most of the way hanging on to a pole for support. In rush hour the city resembles a jungle filled with the honking of automobile horns, the roar of engines, the squeal of tires, the shouts of angry bus riders as the doors of an overcrowded bus are closed in their faces, and the long long lines of men in their machines of transportation.



POPULATION, BY PLANNING AREA
MONTGOMERY AND PRINCE GEORGE'S COUNTIES

NO	NAME	1960	1980	2000
III	Rockville	28 056	68 416	101 868
V	North Bethesda	32,975	79,364	93,369
VI	Bethesda	60,882	93,154	103,504
VII	Kensington–Wheaton	72,129	87,948	97,720
VIII	Four Corners–Colesville	27,063	46,187	86,364
IX	Silver Spring	42,066	54,466	58,727
XII	Lanham–Bowie–Belair	12 911	42,011	102,911
XIII	Hyattsville–College Park	74,260	92,360	124,804
XIV	Bladensburg–Defense Heights	43,191	74,591	92 787
XV	Largo-Belair	3,962	27,962	83,967
XVI	Seat Pleasant	37 729	82,329	96 233
XVII	Suitland–District Heights	38,884	70,684	113,284
XVIII	Oxon Hill	42 763	105,963	168,063
XXI	Laurel	11,276	42,476	126,276

Fig. 1. Planning Areas

Fig. 2. The National Capital Region with Recommended Transportation System

Perhaps this description of the nation's capital is a bit overdramatic, but it serves to point out what happens when the transportation system falls behind the needs of the area, as it obviously has done. This area's major form of mass transportation is the bus, but it is proving to be inadequate in coping with the rising demands of the area. Something must be done before the point is reached where traffic jams up and stops completely.

The transportation problem in Washington, D. C. is comprised of many sub-problems. The present highway-bus network does not and cannot adequately serve the peak hour traffic needs. During rush hour the highways become overloaded, resulting in slower bus service. The riders become dissatisfied with this slowdown and resort to using their cars in the hope that they might be able to reduce their travel time, but the highways become even more clogged. In 1964, less than 45% of peak hour movements in the D.C. area to and from downtown were by bus. By 1975, forecasts show a decline to 25%. More people must be attracted to public transportation if this congestion is ever to be relieved. In cities with a rapid transit system, 70 to 90 per cent of peak hour movements are by public transportation.

WASHINGTON D.C. AREA

Ely Fishlowitz graduated from the School of Engineering and Applied Science in 1965 with a B.S. in Civil Engineering and is now a Structural Research Engineer at the U.S. Naval Ship Research and Development Center. He is also working toward a Masters Degree in Engineering at GWU. As an undergraduate student Ely was active in Sigma Tau, Theta Tau, and he was chapter president of ASCE.

Fig. 3. Downtown Rapid Rail Station for the Nation's Capital – DuPont Station

The critical area is downtown. In this area an increase is foreseen in employment and crosstown travel. The amount of traffic expected downtown by 1980 cannot be accommodated even by the largest practicable highway system. Public transportation must handle a major part of this traffic if complete congestion is to be avoided.

AREA GROWTH

The reason for the transportation problem in Washington is growth. The population of the metropolitan area in 1960 was 2.2 million. By 1980, the estimate is for 3.4 million and by 2000, 5 million is the forecast. By the year 2000, almost half the population of the metropolitan area will live in suburban Montgomery and Prince Georges counties. Suburban development has been encouraged by governmental housing and economic policies, but the downtown area reamins the principal employment center. In 1964, 40% of all jobs in the metropolitan area were located in downtown Washington. By the year 2000, the number of jobs downtown is expected to increase by 150%. Figure 1 shows population figures for selected areas of suburban Montgomery and Prince Georges counties. The areas of major future concern are shown with a circle. These areas will need mass transportation service into and out of the downtown area if massive congestion is to be avoided.

RAPID TRANSIT AS A SOLUTION

The form of mass transportation that would best serve this area's needs is rail rapid transit. This opinion is supported by the National Capital Transportation Agency in their plan of 1962 and other revised forms of the plan. It is also supported by the Maryland National Capital Park and Planning Commission in their corridor plan.

Rail rapid transit will provide a swift, efficient mode of transportation for the commuters. One track of rail rapid transit is equal in passenger capacity to eight or ten lanes of limited access freeway. The use of rail rapid transit would result in a more efficient use of land in the Washington, D.C. area because not as much land would be required for highways. Land could be put to other uses such as recreational areas of housing. Without rail rapid transit the amount of land required for highways when the metropolitan area reaches a population of 5 million would be exorbitant. Although both bus and rail rapid transit would theoretically relieve the parking problem, only rail rapid transit would help the problem of congested streets. Buses would still have to use the streets and little relief would be realized. Rail transit would go underground or on median strips removing the cause of congestion from the streets entirely. The basic requirement of rail rapid transit is a separation from highway traffic. This can be accomplished by: the use of median strips between freeway lanes, the use of existing railroad rights-of-way, above ground monorails, and underground subways. Monorails have been discounted by Washington area planners as being too expensive. Past and present plans make use of the remaining three methods. In the 1962 plan by the National Capital Transportation Agency (NCTA) subways were suggested for the City of Washington and the use of median strips on highways and freeways was recommended for the suburban areas. Existing railroad rights-of-way were to be utilized whenever possible. The choice of methods depends on two factors: minimizing right-of-way and construction costs, and minimizing social disruption to existing communities.

Fig. 4. Proposed design For a Subway Entrance

–Continued on Page 14

RAPID TRANSIT—Continued from Page 13

FINANCING

The financing of rail rapid transit facilities is complicated by the fact that there is difficulty in meeting expenses due to a lack of patronage in off peak hours. Also, the rapid transit facilities are used mostly by the people in the suburbs. These users do not pay city taxes which in many cases help to pay the expenses of the facility. Some solutions to the latter problem are as follows. The city limits could be extended, placing the entire area using the rapid transit system under one taxing agency. The county or state could be directed to assume the responsibility rather than the city. A transportation authority could be developed which has taxing powers. A confederation of communities could be formed to act in cooperation for transport planning, operation, and financing. (This plan has been used successfully in the Toronto, Canada area.)

AREA DEVELOPMENT PLANS

The Year 2000 Plan for the Washington, D. C. area has as two of its goals efficiency of land use and efficiency in the transportation of people and goods within the metropolitan area. In this plan, the National Capital Planning Commission (NCPC) recommended that outward growth be channeled along a few corridors radiating from the city and separated from each other by wedges of open space. The NCPC also recommended the use of rail rapid transit to serve existing or potential high-density development. A glance at the circled areas of Fig. 1 shows the trend toward these corridors. This type of growth is very well suited to service by rail rapid transit running in each corridor radiating from downtown. Two of the major policies of the Year 2000 Plan are: metropolitan growth should be based on six corridors of urban development (four extending into Maryland and two into Virginia), and each corridor should be served by rail rapid transit and freeways making downtown accessible from all parts of the metropolitan area.

In 1962, the Maryland National Capital Park and Planning Commission (MNCPPC) published a plan for development of suburban Maryland based on the corridor concept of the Year 2000 Plan. The goals were similar to those in the 2000 plan; efficient land use, maintenance of open space, and provision of an efficient transportation system including rail rapid transit. The MNCPPC felt that without the rapid transit system, highways and parking garages will consume the downtown areas decreasing the advantages of central location and resulting in a fragmented and unworkable city.

OTHER SOLUTIONS

Although there is now substantial agreement on the desirability of rapid rail transit as a solution to the D.C. area's transportation problems, other alternative solutions were proposed by planners and discussed at length. One of these is an all highway system with no improvement in public transportation. This was rejected for reasons stated earlier, namely impossible peak hour traffic loads, intolerable congested by 1970, and the fact that the system could not serve the growing area. Another proposal was for an all highway system with improved bus transportation. This would mean giving buses special traffic islands and loading bays, suburban bus stations, bus lanes on highway median strips, exclusive streets for buses only, and a bus subway. This proposal was rejected as inadequate and too expensive. The maximum capacity of a bus subway is 7,500 persons per hour in one direction compared to 35,000 for rapid transit. The bus subway would shortly have to be replaced with a rapid transit service.

THE NCTA

In 1960, Congress created the National Capital Transportation Agency to prepare a transportation program for the national capital region and with congressional approval to construct and provide for the operation of mass transportation facilities. In 1962, the NCTA published its recommendations with the following aims in mind: to develop a plan that will meet the region's present and future transportation needs and assist regional development at the least possible cost and with a minimum disruption and relocation of business. In their traffic forecasting methods the following factors were of importance: purpose of trip, economic status of trip taker, relative travel times (public transportation vs. private car), relative convenience, and ratio of travel costs. The formulas used to predict how people will travel in the future (car or public transportation) were similar to those used in Toronto. In Toronto the formulas were used several years ago and the current situation is in close agreement with what was predicted.

THE 1962 NCTA PLAN

The prime objectives of the NCTA plan are: the movement of people quickly and at low cost from widespread and distant residences to the downtown business area, and the provision of rapid distribution free from conflict with surface traffic. The principal features of the plan are as follows. There will be two subway routes crossing twice downtown. The downtown system will be extended throughout the District and suburban areas via seven rapid transit rail routes and one commuter railroad route (Fig. 2). The stations will be designed to meet the needs of the auto age and will serve as local distribution and collection centers. Express and local bus service in D.C. and the suburbs will connect with rapid transit trains. From a comparison of Fig. 2 and Fig. 1 it is seen that the trains will serve the most densely populated areas of the future and, in fact, serve corridor type areas as suggested in the report by the MNCPPC and in the Year 2000 Plan.

—Continued on Page 26

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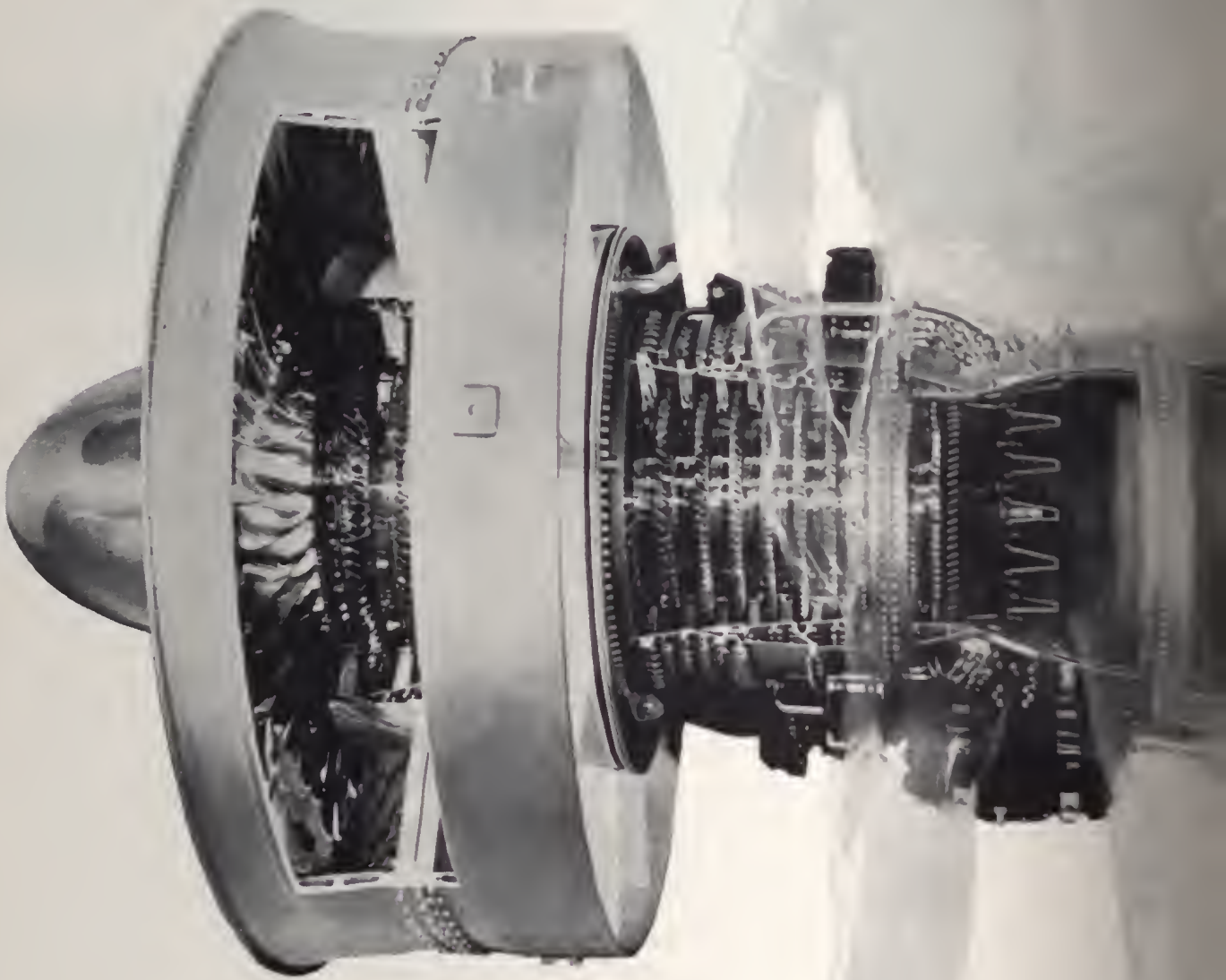

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MECH MISS . . .

Elizabeth Nelson

For December, Mecheleciv's effort at relieving boredom and frustration is embodied in Elizabeth Nelson, a twenty-year-old junior from Westport, Connecticut. Liz is majoring in Art History and enjoys skiing, sailing, and music in the form of singing and piano. She is Vice President of Booster Board, Social Chairman of Delta Gamma Sorority and she has served on several projects such as Homecoming and Spring Concert. She complains that she can't begin to understand the books of a friend of hers who studies mechanical engineering, but that's all right—neither can we.

Photography by Jim Black

INTRODUCTION

The ever increasing demand for single family homes in the Washington suburbs has prompted some of the nation's largest developers to undertake projects of tremendous magnitude in the western portion of Fairfax County, Virginia near Dulles International Airport. One of the major problems facing construction in this area is the presence of subsurface rock at an average depth of 3 ft. below the existing surface.

GEOLOGY

This area is encompassed by a long southwestward-trending belt of Triassic Period rocks. See Figure 1. The Triassic of northern Virginia is a thick wedge of westward-dipping sedimentary rocks and associated intrusive igneous rocks. The most comprehensive geologic study of this belt to date was that by Joseph K. Roberts (1938). Two of the most common formations encountered during construction are listed below.

Figure 1.—The Triassic rocks of northern Virginia

Bull Run shales of Roberts, 1923—The youngest Triassic sedimentary rocks; alternating fine to coarse-grained shale colored red, gray, blue and black, altered in places by intrusive diabase.

Diabase—Diabase or "trap rock" is an igneous rock in flat bodies called "dikes" (cutting across beds), "sills" (intruded between beds), and irregular bodies called "stocks" are intruded into the Triassic sedimentary rocks.

The width of the belt is about 15 miles. Roberts (1928) estimated the thickness in this area to be 1,000 to 1,500 feet. In general, the structure of the Triassic sedimentary rocks is monoclinal. Locally the rocks are faulted, or the dip is altered as a result of the intrusion of diabase.

ECONOMY OF CAREFUL PLANNING

When developers moved into the area and reviewed the detailed reports on subsurface conditions they knew that nearly every foot of pipe and utility trench would require some excavation in rock. The current price for trench excavation in rock in Fairfax County is $18 per cu. yd. This means that the cost of sanitary sewer excavation would average about $14 per lin. ft. Such costs could make a project unfeasible.

It was decided to employ predrilling and blasting methods. This required that every sanitary sewer, water line, gas line and storm drainage facility, Figure 2, be staked out to

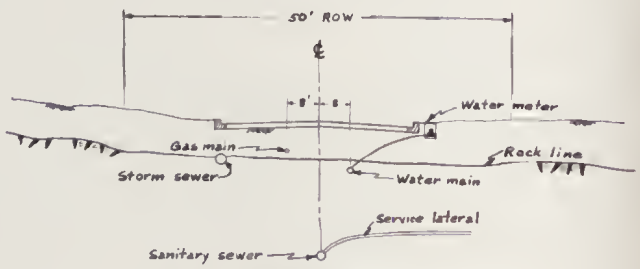

Fig. 2. Typical section of a street

exact line and grade. These facilities were then drilled from the existing ground surface to grade elevation, plus whatever additional depth was required for adequate breakage of rock to grade. After blasting was completed in a designated area, the contractor for pipe work was allowed to move in and begin his work. Payment was made under contract unit prices but without a rock excavation item. This method of pre-blasting accounted for savings of 50 to 70 percent under conventional rock excavation costs.

IN A ROCK AREA

by Lawrence J. Kastner, Jr.

Engineering layout must be accurately done to assure that the underground facilities will fit in the pre-shot zones. Stake out should be done on centerline so the hubs will be destroyed by the blast. After an area has been completely shot, offset lines will be staked for the pipe crews according to their priority.

For most areas a single line of holes has been adequate for pipe diameters up to 15 in. and at depths up to 18 ft. See Figure 3. In general, the pre-shooting makes it impossible for a backhoe with a 30 in. bucket to clean the

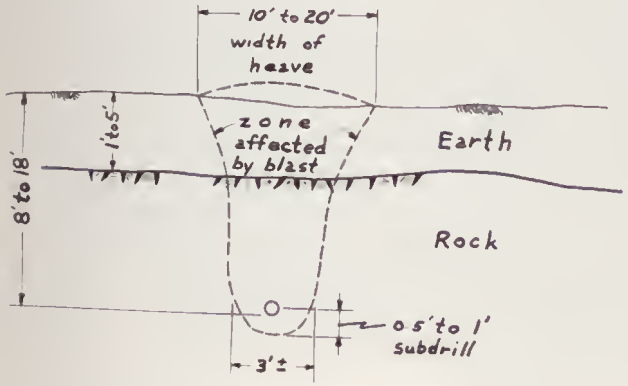

Fig. 3. Preblasting zone with heave

invert. The depth of subdrilling required below the bottom of the pipe varies greatly with the type of rock. An overdepth of 2 ft. in red shale and 4 ft. in trap rock will give satisfactory breakage. Dynamite is used in shallow holes; fertilizer and dynamite combinations are best for deep holes.

Trap rock areas have a problem of excessive heave accompanied by breaking in large slabs (some of these slabs pulled out with cables measured 6 ft. by 3 ft.). Better fragmentation can be attained by reducing the hole spacing, or by using a double row of holes. A test section gives dependable advance information but changes will be indicated as work proceeds.

Production results are obtainable by doing a segment of the sanitary and water facilities simultaneously with the related house service lines. The heave from the blast can be flattened or removed. The storm drainage and gas facilities are then drilled and shot. The site is then restaked for the pipe contractor.

GOOD ENGINEERING ESSENTIAL

Careful engineering layout is the key to the entire program. All stake-outs must be accurate, otherwise a pipe crew may wind up excavating a trench parallel to but 3 ft. off the pre-shot line. The problem of subsurface rock can be overcome if an economical system of pre-shooting can be used.

NOTES FROM INTERNATIONAL NICKEL

STAINLESS NAILS

Special nickel stainless steel nails have been developed for attaching redwood and cedar siding. Available in colors to match the siding, the nails will not corrode and stain.

RAILCAR STEEL

Practically all the new passenger cars built for railroads in the United States during the past 20 years have been sheathed in gleaming nickel stainless steel.

DIVERSE DIVERS

Deepsea divers, operating hundreds of miles from the nearest sea, were important to the success of a mining operation in Northern Manitoba. The divers plunged into 60 feet of swampy water to help sink a mine shaft being developed for International Nickel.

BATTERIES BETTER CAMELS

The vented rechargeable nickel-cadmium batteries used for emergency lighting have been designed to require addition of water only once every 10 years.

MORE NICKEL

To help meet the world's growing demand for nickel — up by 70 per cent in the last four years — International Nickel is spending more than $100 million in Canada for new mine and plant development in 1967.

POOL HARDWARE

For trouble-free performance in home swimming pools, filters, handrails, ladders, light niches and piping are made of nickel stainless steel.

FACULTY SPOTLIGHT

by Peter Austin

Mr. Charles E. Pinkus

Mr. Pinkus, another new member of the SEAS faculty, is an instructor in Engineering Administration. This semester he is offering courses in undergraduate statistics (ApS 115) and a graduate Production Management (ApS 253). His main area of interest is in Operations Research and he is presently working toward his Doctorate in this field.

Mr. Pinkus received his undergraduate instruction at the Rutgers University studying under a combined program in which he received a B.S. and a B.A. in Industrial Engineering in 1960. He then studied at Cornell University where he received his M.S. in Industrial Engineering in 1962. While at Rutgers Mr. Pinkus was editor of the Rutger's Engineer, the school magazine.

From 1962 to 1965, Mr. Pinkus worked in the Peace Corps. His assignment took him to Malaysia where he taught all levels of high school Mathematics and Physics. He feels that this was one of his most rewarding experiences. He lived in a very small community and was able to acquire first-hand information about the people and their problems and desires.

Upon returning from Malaysia, he joined the Industrial Management Consulting firm of Price Water House of Philadelphia where he worked in a management consultant group. About six months after joining the Price Water House firm, he was granted a leave of absence to join a foundation in Indianapolis engaged in the study of hard-core unemployment.

The group of people who are classified as the hard-core unemployed are those who are employable but for some reason are not able to hold onto their job. The study group supported by the foundation had the job of finding the reasons for this type of unemployed group. Working with the Chamber of Commerce and other members of the local business community, the group found considerable success. In the year and a half that Mr. Pinkus was with this team, they were able to help many people find and hold onto productive jobs. The group is still in existence finding more and more success in attaining their final goal. Mr. Pinkus feels that this type of study with the help of the unemployed and the business community was very successful and that it could probably be applied in many other areas of the county to great success.

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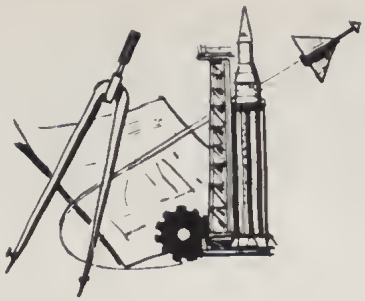
TECH NEWS



Edited by James Wong

SPECTRUM SURVEILLIANCE SYSTEM

A Spectrum Surveillance System designed by Electro-Metrics Corporation, a subsidiary of Fairchild Camera and Instrument, has been developed to sweep the spectrum from 20 Hz to 1000 MHz and plot simultaneously both the average and peak readings of received signals. The instrument is basically designed for automated RFI/EMC testing and consists of two sub-systems. The first subsystem provides for rapid CRT spectrum display of an octave at a time in the form of frequency vs. amplitude. This also allows the selection of individual signals and provides display in either linear or logarithmic form. The second subsystem provides "hard copy" using a dual-pen 11" x 17" X-Y plotter which can automatically record the output of all 16 bands of the system on a single piece of paper. By recording both peak and average at the same time, signal and modulation types can easily be determined. Control of the receivers during the recording process is accomplished through a built-in programmer which provides the flexibility necessary to handle any combination of the 16 bands. The system is called FSS-250 and is the first system of its type to utilize all solid-state, voltage-tuned receivers.

GEOMETRY AND INERTIA AS A BASIS FOR FACE SEALS

At the annual meeting of the American Society of Mechanical Engineers, held in Pittsburgh, Nov. 13-17, Dr. H. J. Sneck presented two papers stating that geometry and inertia may play important roles in leakage sealing properties of face seals. He proposed an unusual technique for treating shear flow that generates turbulence which in turn affects pressure flow-diametrically opposing forces. He also proposed a treatment of the viscosity or friction effect to alleviate resulting problems.

The papers covered laminar flow (particles in fluid moving in parallel layers) and turbulent flow (velocity of flow of/and within a fluid) in face seals. They further demonstrated that geometry and inertia may play an important role in that this behavior is directly related to certain fundamental concepts that have been overlooked or perhaps thought to be inconsequential.

Dr. Sneck is presently a professor at Rensselaer Polytechnic Institute having received his undergraduate degree from RPI; his master's degree from Yale University and his doctorate from RPI. He has also been a consultant for General Electric's general engineering laboratory and is a member of the American Society of Mechanical Engineers, the American Society of Lubrication Engineers and the Society for Automotive Engineers.

FRICTIONLESS AIR CUSHION BOAT

A frictionless air cushion boat designed by Gary D. Howsley, a graduate industrial design student at the Cranbrook School of Art, Bloomfield Hills, Mich. in conjunction with the Dow Chemical Company of Midland, Mich. Howsley designed the craft from four separate angles—sketches, finished drawings, scaled model and full scale working model with Dow providing the materials used in the final project. Utilized were such materials as foams, epoxy resins, cloth, polyester resin and nylon reinforced vinyl. Dimensionally, the craft is 7½ feet in diameter, with a 14-inch hull depth. The deck of the "hovercraft" is about five feet across and consists of a one-inch layer of high density Styrofoam brand plastic foam sandwiched between layers of epoxy resins and cloth. The final deck thickness is 1¼ inches, providing stability and strength without weighing too much. Attached

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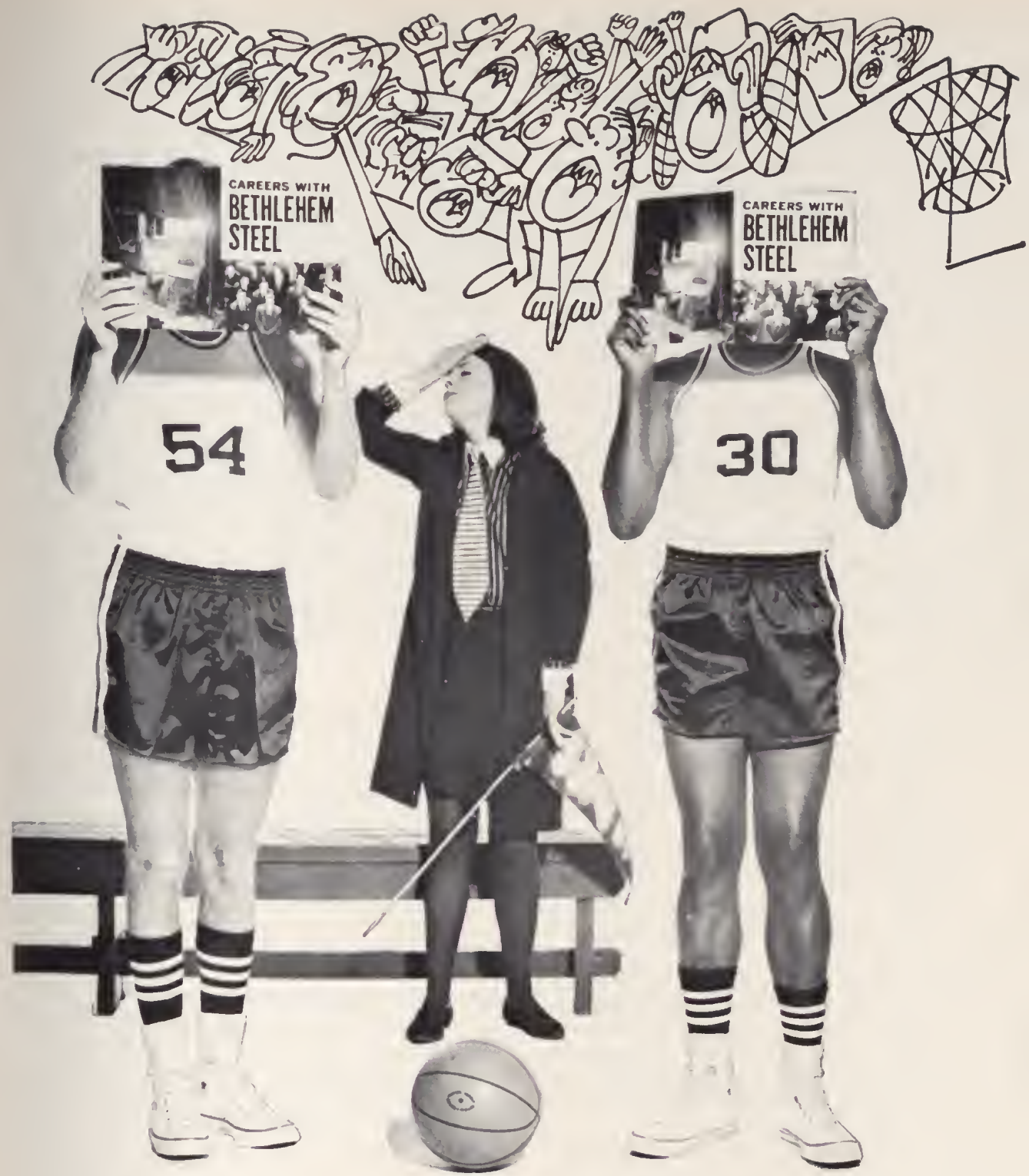

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BETHLEHEM STEEL

BETHLEHEM STEEL

The rapid transit system was planned to consist of 83 miles of track and 65 stations (14 of them downtown). Nineteen miles of the system will be underground, 26 miles of it will use existing or future freeway median strips, and 24 miles will be on existing railroad rights-of-way. The commuter line will be 15 miles long and have seven suburban stations. The 14 downtown stations will be located so that almost 80% of the people employed downtown will be less than a five minute walk from their job to a station.

In addition to the rail rapid transit system, the NCTA recommends supplemental express buses along the George Washington Memorial Parkway, Suitland Parkway, Shirley Highway from Lincolia to the Pentagon, and service to the Anacostia-Bolling area including the Naval Research Laboratory. Also recommended is 50 miles of freeway construction.

This plan involves a capital outlay of $793 million. The entire capital investment is expected to be recovered within 40 years of the systems completion. Engineers see no special problems with respect to subway construction. In three-quarters of the downtown system's construction it will be economical to use tunneling rather than cut and cover methods. This will minimize disruption in the downtown area. In tunneling, the street is not removed. In cut and cover methods, the street is removed, the section of the subway is completed, and the street is rebuilt after filling in operations.

Also included in the plan is a proposed fare structure.

within D.C.	25¢
outside D.C.:	
less than 8 miles from center (Falls Church and Bethesda)	35¢
8-12 miles from center (Springfield and Kensington)	45¢
more than 12 miles from center (Fairfax and Rockville)	55¢

In almost all cases, the fares are equal to or less than existing bus fares.

In summary, the NCTA plan recommends: a coordinated system of highway and rapid transit facilities, the previously mentioned rail rapid transit system, the use of modern air conditioned high speed equipment, minimizing noise, planning stations to accommodate the person who drives his car to the train, bus feeder systems to the rail stations, and an expanded highway system.

Although badly needed and very well planned, the NCTA 1962 plan was rejected by Congress. The big reason was the cost plus the method of financing which called for the federal government to guarantee bonds. There was also a general opinion that such a system could never pay for itself because it would be utilized to its fullest extent for only a few hours a day.

THE 1964 NCTA PLAN

In 1964, the NCTA proposed a reduced rail transit scheme. This was an effort to get something started in the D.C. area toward the solution of the transportation problem. The proposal is for a 15 mile system including a major crosstown route serving D.C. Armory and Stadium. This plan calls for 2 routes mainly within the city of Washington. There still remains the problem of serving the majority of suburban commuters. However, once installed this system could easily be expanded to take care of future needs of the area. The system would carry 34,000 riders during the peak rush hours and reduce traffic by 6,000 autos at a cost of $287 million. Although the NCTA still prefers the 1962 plan, this version is intended to provide a less expensive system that will do the job now. The 1962 plan represents an answer to the area's needs in the future.

In 1964 the District made a decision to build its freeway system based on estimates that most future rush-hour commuters headed downtown will use a transit system. This means that Congress and local governments will have to build an improved transit system including rapid transit. If they do not, the freeway system will quickly become obsolete. According to the D.C. Highway Department's plan, freeways will be expected to carry over 40% of downtown-destined rush hour commuters in 1975. The other 60% will be expected to use transit. The highway department realized that it is impractical and nearly impossible to handle the future needs with highways alone. They had no choice but to depend on a transit system.

MONTREAL, CANADA AND SAN FRANCISCO

In looking at subway systems in other cities, it is observed that the Montreal, Canada metropolitan area is about the same size as Washington's and currently has operating a $214 million subway system with 15.9 miles in trackage. Both cut and cover and tunneling methods were used in the construction of the system.

On a recent visit to Expo '67, the author had an opportunity to ride the Metro, as the Montreal subway system is called. It is entirely underground and runs on rubber tires rather than the conventional steel wheels. The trains are fast and quiet, and their interiors are comfortable. The stations are well designed for the movement of large numbers of people to and from the trains.

The San Francisco Bay area is scheduled to have a rapid transit system completed in the early 1970's. The San Francisco area is 45 square miles in area compared to D.C.'s 69 square miles, but the population is greater (2,057,555 vs. Washington's 2,001,897 as of 1960 census). Their system consists of 75 miles of rapid transit at a cost of $1.2 billion. The San Francisco Bay area has a strong transit tradition with interurban rail systems in prewar years and an existing commuter line to the south of the Bay area. The residents of the area voted to tax their property for the next 40 years to help pay for the system. The transit company is publicly owned and the plan has the backing of the business community. The transit district won legislative approval for $130 million in state aid and received lobbying

aid from the local AAA which felt the trains would reduce congestion and benefit its motorist members.

WASHINGTON'S RAPID TRANSIT SYSTEM

During the early 1970's, Washington, D. C. will open its long awaited rail rapid transit system and join with Montreal, San Francisco and 27 other cities of the world in the use of rail rapid transit to relieve city transportation problems.

The NCTA plan approved by Congress calls for a system that will be 25 miles long and cost $430 million. The Washington Metropolitan Area Transit Authority (WMATA) will direct the system. Construction is scheduled to begin in 1968 and completion is hoped for by 1972. Figure 3 presents a map of the system. In comparing figure 3 with the 1962 NCTA plan in figure 2 it is seen that the system to be constructed is an abbreviated version of the original 1962 plan. The approved system is well suited for future expansion which will be necessary to serve the growing suburban Maryland and Virginia areas.

When the rail rapid transit system was first announced, local bus companies felt their business threatened. However, NCTA officials pointed out that rail transit will free bus operators from downtown runs which during rush hours are slowed by congestion. The buses will be available to serve in outer neighborhoods where their speed and route flexibility can be employed. They will also be used to carry passengers to and from the train stations. The bus companies and the NCTA are working together to plan revised bus scheduling and new routes.

The rapid transit system for Washington is a major step forward toward a practical transportation scheme for the metropolitan area. It is hoped that when needed, future expansion of the system will be accomplished with little delay in order to keep pace with the growth of the area.

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TECH NEWS—Continued from Page 24

to the outside bottom of the hull is a nylon reinforced vinyl diaphragm that is the key to the ability of the craft to "hover" off the water. The three-horsepower engine on Howsley's craft turns a blower that sends air into the diaphragm causing all parts of the bag to inflate at the same pressure, causing a uniform leakage around the perimeter and thus creating a frictionless surface. Steering and propulsion is provided by means of a jet water pump powered by a separate motor. An impeller brings water up through the intake and to one or both of two nozzles. The twin nozzles from the jet direct steering—turning the steering valve to one side would cut off the flow of water to the nozzle on the side thus giving thrust to the opposite and direction to the craft.

WASTE TREATMENT

From the logic of baby pants, egg beaters, and Niagara Falls came a design for a $600,000 purification system at a paper mill. The baby pants, made of polyvinyl chloride (PVC) film, keep moisture where it belongs — or rather, from seeping to where it doesn't belong. On a much larger scale, a huge sheet of heavy-duty PVC film manufactured by The Goodyear Tire & Rubber Company is keeping waste water from seeping out of the pond at the Weyerhaeuser Company's pulp and paperboard plants. The vinyl was used to line a 22-acre aeration lagoon where waste water is oxygenated before being returned to the river. Four egg beater-like aeration machines, each with 32 blades and powered by 75-horsepower motors, float on the pond and churn oxygen back into the liquid, much as water becomes oxygenated as it tumbles through the air over Niagara. The machines add 21,600 pounds of oxygen a day to the 80-million-gallon, 12-foot-deep lagoon, promoting biological oxidation. The lagoon, 2,000 feet long and up to 600 feet wide required the vinyl liner because it is located in the river plain where soils will not hold waste water without seepage. Before entering the lagoon, waste water containing sugars and starches is left for a day and a half in settling basins, where particulate matter is settled out. It then spends 11½ days in the aeration lagoon before returned to the river. The system is designed to reduce the mill's total oxygen demand on the river from 16,000 pounds to 4,000 pounds of biochemical oxygen demand (BOD) per day during the summertime low flow period. This converts to about four pounds of BOD per ton of pulp produced, well below the 20 to 25 pounds per ton average of kraft mills in the Pacific Northwest.

COMPLEMENTARY UNIJUNCTION INTEGRATED CIRCUIT

A low frequency trigger device that has uniform characteristics and extremely stable operation has been developed by the General Electric Company. Designated the D5K1, it operates in an opposite polarity mode compared to standard Unijunctions. Ultrastable, long-time interval analog times are now possible since the device allows stable oscillators to be built with frequencies up to 11KHz. It can produce both a positive and a negative trigger pulse and with this oscillators and timers can be precision temperature compensated and calibrated simultaneously in one simple step at room temperatures. Oscillators built with the new circuit have been shown to rival crystals for stability.

GE4 TURBOJET ENGINE

The GE4 engine which will power the United States supersonic transport (SST) is built by the General Electric Company and is 25 feet long, six feet in diameter, and is rated at 60,000 pounds of thrust, or more than three times as powerful as any jet engine in commercial use today. The engine is an after-burner-augmented turbojet engine which has a cruise capability of Mach 2.7 (1,800 miles per hour). The engine is being built for the 250-passenger United States SST which is being built by the Boeing Company and is being manufactured at GE's Flight Propulsion Division at Evendale, near Cincinnati, Ohio.

CONSTRUCTION

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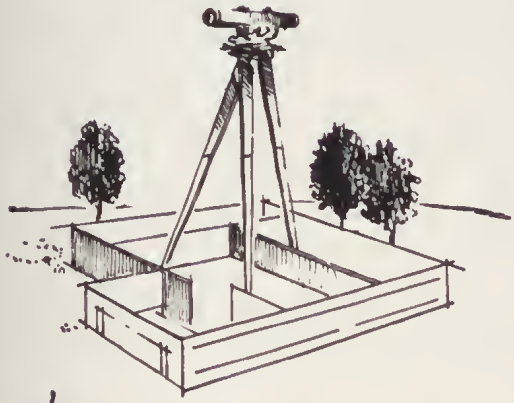

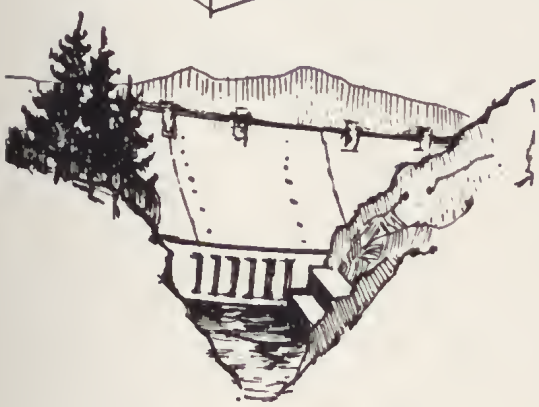

■ The world's foremost and largest engineering organization In the construction field, pioneering new and advanced engineering practices and concepts.

■ An organization whose work spans virtually the entire range of modern engineering, including comprehensive planning for development of water and related land resources of entire river basins; design and construction of multi-unit, multi-purpose, integrated systems that encompass navigation, flood control and major drainage, hydroelectric power generation, municipal and industrial water supply, irrigation, water quality control, beach erosion control and hurricane protection, water-oriented recreation, preservation and enhancement of fish, wildlife, ond natural beouty values; and planning, design, and construction of complicated, advanced-concept military structures such as the Nike-X anti-missile system, launch facilities and bases for the intercontinental ballistic missiles, airfields, housing, schools, laboratories, and nuclear power facilities. In addition are the allied fields of cartography, geodesy, mathematics and engineer intelligence.

■ An organization that recognizes each engineer as on individual, providing well-rounded career development programs with on-the-job training; courses at government expense in colleges, universities, and seminars as necessary to assure steady progression to top professional and managerial levels; encouragement ond ossistance in attaining professional registration and recognition; and an opportunity to win national and international awards.

■ An organization with offices and projects in nearly every one of the 50 States and in many foreign countries that encourages employees to further their development by accepting new and challenging assignments.

■ An organization which provides excellent rotes of pay with liberal fringe benefits, including generous retirement annuity, complete health and life insurance coverage, paid vacation leave, military training leave with pay, generous sick leave; and special pay awards for outstanding performance and suggestions that improve operating efficiency.

If you're thinking this is all too good to be true, you're wrongl All of the above is available to you in a civilian engineer career with the U. S. Army Corps of Engineers. If you are interested, you can get further information from the Chief of Engineers, Department of the Army, Washington, D. C. 20315.

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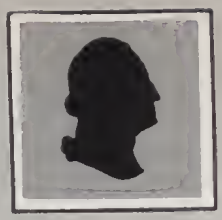
WRITE FOR AN ILLUSTRATEO BROCHURE "YOUR CAREER"



Office of the President

Memorandum to the School of Engineering and Applied Science:

I am pleased to announce that Dr. Harold Liebowitz has accepted appointment as Dean of the School of Engineering and Applied Science and Professor of Engineering and Applied Science effective February 5, 1968.

Dr. Liebowitz comes to George Washington from the Office of Naval Research, as Engineering Advisor and Head of the Structural Mechanics Branch. He holds the bachelor's, master's and doctorate from the Polytechnic Institute of Brooklyn, and brings to the campus an excellent and varied background from education, government and industry as administrator, teacher, author and researcher.

At this time I want, on behalf of the University, to extend to Acting Dean Herbert E. Smith a sincere vote of thanks for his effective stewardship of the School over the past several months.

Lloyd H. Elliott

December 13, 1967

THE
GEORGE
WASHINGTON
UNIVERSITY

Washington, D.C. 20006

INDEX TO ADVERTISERS

THE SHAFT

A clergyman and a truck driver found themselves in an automobile smashup. The truck driver told the minister what he thought of him in profane terms. When he paused for breath, it was the clergyman's turn.

"You know, my good man, that I cannot indulge in your kind of language, this much I will tell you; I hope when you go home tonight your mother runs out from under the porch and bites you."

* * *

An automobile dealer who doesn't enjoy a good reputation advertised that he would give away a blonde with each car. A delighted young wolf bought a car and rode with his newly-won blonde into the country and parked. He kissed her, and then whispered in her ear. "No," she replied, "you got that when you bought the car."

* * *

An E. E. we know broke his arm fighting for a woman's honor. It seems that she wanted to keep it.

* * *

Then there was the groom who finished his wife's first breakfast, muttering, "Can't cook either."

* * *

A young man contemplating matrimony wanted to propose and didn't know how, so he went to his dad for advice.

"Well, son," said the old man, "I don't know that I can help you much. With me and your Maw it happened one Sunday evening, when yer Maw and me was asittin' on the sofa. We was just a talkin' along and purty soon yer Maw leaned over and whispered in my ear and I said, 'The hell you are,' and the next day we were married."

* * *

In days of old, when told a naughty story, the coed would blush. Nowadays she memorizes it.

* * *

A pessimistic fellow read his horoscope, which said: "Make three new friends and see what happens." He went out and made three new friends and nothing happened. Now he complains he's stuck with three new friends.

* * *

The engineer:
He only drinks to calm himself
His steadiness to improve.
Last night he got so steady,
He couldn't even move.

* * *

The man didn't say a word when they ran over his cat with a steam roller. He just stood there with a long puss.

* * *

Next to a beautiful girl, sleep is the most wonderful thing in the world.

* * *

"Show me a home where the buffalo roam, and I'll show you a house full of chips!"

* * *

The parrot ate nothing but navy beans . . . he was trying to be a Thunderbird.

* * *

They've got a new parlor game called BUTTON, BUTTON, HERE COME THE FOLKS!

* * *

History credits Adam and Eve with being the first bookkeepers, because they invented the loose-leaf system.

* * *

They don't come any smarter than the guy who was able to talk his wife into being sorry for the girl who lost her hairpins in the back seat of his car.

* * *

A man of German descent named Sexauer had borrowed some money from a small loan company and became delinquent in repaying it. Mr. Sexauer worked for a huge corporation which employed a big office staff composed of several comely secretaries. After allowing the debt to run for two months, the loan company sent an agent to see their debtor; and when the agent walked into the office, he asked, "Do you have a Sexauer here?"

"Sex hour? Why we don't even have time for a coffee break."

SATELLITE TRACKING SYSTEMS
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And you still call us a phone company?

We really don't mind.

After all, it wasn't that long ago that we were just in the telephone business. But now, because we're involved in so much more, we need bright college graduates with practically any kind of degree, whether it's in Engineering or Commerce.

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"Traffic is terrible today!"

". . . Accident in the left hand lane of the Queens-Midtown access ramp. Right lanes moving slowly. Fifteen minute delay at the Brooklyn Battery Tunnel. Lincoln Tunnel backed up to the Jersey Turnpike. Extensive delays on Route 46 in the Ft. Lee area. That's the traffic picture for now, Bob."

However, technical people at GE are doing something about it. Development and design engineers are creating and improving electronic controls and propulsion systems to guide and power transit trains at 160 mph. Application engineers are developing computerized traffic control systems. Manufacturing engineers are developing production equipment and new methods to build better transportation products. And technical marketing specialists are bringing these products and systems to the marketplace by working with municipal and government agencies.

Young engineers at GE are also working on the solutions to thousands of other challenging problems—products for the home; for industry; systems for space exploration and defense. When you begin considering a career starting point, think about General Electric. For more information write for brochure ENS-P-65H, Technical Career Opportunities at General Electric. Our address is General Electric Co., Section 699-22, Schenectady, New York 12305.

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